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— from the Association's By-Laws

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IMPACT of Electronics on Data Processing

by C. J. Craft

DURING THE PAST FEW YEARS, there has been much interest in electronics accompanied by many claims for what it can do. Some have said that electronic data processing will in the next decade replace office workers on a wholesale basis. A few even claim that computers will take over from executives many of their decision making functions. More importantly, however, some significant changes in business data processing attributable to electronics have already occurred. Many routine accounting operations have been either drastically altered or entirely eliminated. And undoubtedly, electronic data processing has done more to change administrative procedures than anything else. Thus, the interest in electronics is sound and some of the claims are based on fact. On the other hand, as we shall see, much of the publicity is just sheer nonsense.

Five Important Advantages

Well, what are the features of electronic data processing that encourage people to take such an interest in it? Why can we expect to see further changes in the nature of accounting operations and their underlying records? Basically this is because of five important characteristics or advantages of electronic data processing which set it quite apart from tabulating and other machine operations, and they are: (1) the tremendous capacity for the storage of information, (2) the unique ability to perform certain logical or decision making functions, (3) the extremely fast computing and processing speeds, (4) the almost unbelievable accuracy of these machines, and (5) the ability to store and follow automatically a lengthy program or set of instructions which describe a particular operation.

First, let us consider the ability of electronic computers to process and store large quantities of data. In most practical applications presently being solved on these machines it is necessary to have readily available in some mechanically or electronically readable form tremendous volumes of data. In one utility billing application being planned on a large-scale computer, about 500 to 600 characters of information for each customer will be stored electronically on magnetic tape (much like the tape used on home recorders). With over 1,000,000 customers scheduled for conversion to this operation, this means a total storage requirement of over a half billion characters. Even though information is very densely packed on magnetic tape at 128 characters per linear inch, this will still require more than 600 reels of tape each 1,500 feet long. By contrast, however, this same quantity of information storage would require over 6 million punched cards stored in more than 2,000 filling drawers.

But more important than the sheer magnitude of the information or data which can be fed into or out of a computer is the ability of the machine to readily use this data. Most computing machines can operate up to 10 tape handling units. With about 2 to 5 million characters of information stored on each reel of magnetic tape, this means that an electronic processor can presently handle at one time up to a maximum of about 20 to 50 million characters of data. And incidentally this information is readily available since the magnetic tapes can be read at the rate of 75 to 100 inches per second, or 15,000 to 20,000 characters per second. Compare this to a maximum card reading speed of 1,000 cards per minute, or only slightly over 1,000 characters per second.

In addition to tape storage, most electronic computers also have an internal memory ranging in capacity from 20,000 to 100,000 characters of information. Data stored in the internal memory of a machine has the unique feature that every character stored in it is available for use almost instantaneously (in a matter of thousandths or millionths of a second). Incidentally, this type of storage is often called random or rapid access memory.

An interesting recent development in this area is I.B.M.'s new Random Access Memory system. It will store over 6,000,000 characters, and has an access time of ½ second. This means that one can get any piece of information in this system in about ½ a second. Needless to say, there is no other nonelectronic way to store such quantities of information where one can get any particular part of it in so short a space of time.

Another advantage of electronic storage is the ability to have a large quantity of information about a particular kind of transaction or item available close together. In a magnetic tape system it is quite common to store anywhere from 500 to 1,000 alphabetic and/or numeric characters for each account or unit record in a file. Moreover, all of this information is usually brought into the internal memory of the computer during the processing of, say, a transaction. This means that all the information associated with an account can be scanned electronically during a posting operation thus adding great flexibility to electronic data processing over punched card equipment.

This large capacity to perform many operations involving a great deal of data has enabled users to achieve a high degree of integration. For example, on punched card equipment, primarily because of the limitations in card and calculator capacities, operations are often broken down into several machine runs or procedures. For example, in one punched card application involving invoice billing there were four separate operations for: billing, inventory control, accounts receivable, and sales statistics. However, with a medium-sized electronic computer, the company plans to handle the entire operation in one run through the machine and still utilize only half the capacity of the machine. A corollary benefit in this case was a vast improvement in the speed of report preparation. One particular sales statistics report will be available in a few days' time as compared with the several weeks presently required.

The second important feature of electronic computers is their unique ability to perform certain logical and decision making functions. For example, these machines have the ability to choose a particular course of action from a range of alternatives based upon some criterion. This fact alone adds tremendously to the capability of these machines over the older types of equipment. What this means is that it is possible to instruct electronic machines to do one thing if, say, there is sufficient inventory on hand, and then to take an entirely different course of action for the reverse situation.

In any practical application like, say, payroll processing on a computer, there are literally thousands of such decision steps or operations required to provide for the myriad of possible alternative situations that arise in such a problem. As a matter of fact, this ability of a computer to make decisions actually has indirectly gotten some users into difficulty by enabling them to instruct or program their computer to handle many or all of the possible exceptions to a particular operation. Generally speaking, exceptions can be handled more economically manually or in some other way outside the machine. This is particularly true when the volume of exceptions is low.

A third feature of electronic computers is the extremely fast computing and processing speeds of most electronic systems. As a matter of fact, these machines can perform arithmetic operations so quickly that the users of electronic equipment use quite different measures of time than we are normally accustomed to. The times required to perform the various operations in a computer are generally measured in thousandths of a second for the slower machines and in millionths of a second for the faster large-scale machines.

As an example of the speed of these machines, two of the largest and most widely publicized computers in this country, the I.B.M. type 705 machine and the Sperry Rand Univac II, will both perform an addition or a subtraction of two 10-digit numbers in about 200 millionths of a second. This is equivalent to about 5,000 such operations in one second's time. Multiplication generally is a much slower operation on these machines since it is performed by the brute force method of successive additions. Still in all, however, the I.B.M. 705 or the Univac II will multiply two 10-digit numbers in 2 thousandths of a second, or about 500 such computations per second. Division is usually even a slower operation than multiplication, at a rate of only about 250, or less, divisions per second. Despite these slow speeds for multiplication and division, that is, relative to addition and subtraction, these machines are still awfully fast by comparison with the speed of punched card equipment where the maximum speeds are in the order of only 2 to 20 operations per second, as compared to 250 to 2,500 operations per second for the computer operations mentioned.

The fourth, and possibly least often discussed feature of electronic processing, is its almost unbelievable accuracy as compared with alternative methods of computing. This is achieved primarily as a result of the great care which the computer manufacturers have taken in the design and construction of these machines. For example, most computers include automatic checking operations which verify that data has been read correctly from the

magnetic tapes and transferred within the machine without any loss of information. The arithmetic or computing operations are also usually checked in one way or another. In the case of the Univac, the electronic equipment is actually duplicated thus providing for two independent computations of the same data which should produce the same answer; if it does not, the computer stops and indicates an error.

Electronic calculators actually operate many hours without making a mistake. When one realizes that just one hour of such operation on a large-scale computer is equivalent to several years on a desk calculator, their degree of accuracy is almost unbelievable. Thus, when dependability is measured in terms of the work done between errors, electronic processors are more accurate by several orders of magnitude than any human or mechanical system. And what is more important, when the machines do make a mistake they generally provide some indication of the error, either as a result of the built-in checking, or because of the instructions or program which the user puts into the machine.

In regard to the reliability of magnetic tape operations, most computers incorporate checking operations, usually called parity checks, which in a sense are simply a means of keeping track, or totals, of the magnetic spots recorded on the tape. Using such checks for detecting errors, one manufacturer carried out extensive experiments on the reliability of tape. The results of these tests showed that the frequency of errors detected by the parity checks was about one error per half billion characters. Furthermore, 97% of these errors were eliminated simply by rereading the tape. Thus, if we ignore these errors eliminated by rereading, and incidentally such errors are generally corrected automatically, we arrive at the fantastic figure of less than 3 errors per year of operation.

A final point that should be made when discussing the features of electronic computers is their ability to store and follow automatically a lengthy program or set of instructions which describe a particular operation. In other words, once a computer has been instructed what to do and is given the information to process, it will proceed automatically to perform all of the steps of the operation in their right sequence. This ability results in the elimination of much clerical effort, like card handling and the transferring of operations from one machine to another, which is necessary in tabulating systems.

So as not to oversell electronic data processing, let us review briefly some of its limitations. First of all, computers are very complicated and require considerable skill to instruct or program. Moreover, despite all the implications to the contrary, these machines are not very intelligent. They cannot perform in and of themselves any unplanned-for operations. Consequently, it is necessary to plan computer operations in great detail. This is why it usually requires many man-years to put a clerical or punched card operation in the necessary form for the computer.

As a matter of fact, the high cost associated with this conversion to electronics raises the serious question in some cases whether some computer programs are economically feasible. Also, quite frequently there arise situations where a computer cannot be justified on the basis of estimated savings unless the scope of the contemplated applications is broadened to achieve a greater consolidation of files and/or to include other related operations.

Notwithstanding earlier remarks to the contrary, computers do make errors. And since these machines are so complicated, it is understandable that some equipment failures are difficult to diagnose and require skilled maintenance engineers to handle. Also, preventive maintenance programs designed to overcome this problem to some extent require up to 15 to 20 per cent of the total available time of most machines. More important, however, clerks feeding information into an electronic system make errors. And these machines will make a wrong calculation just as rapidly as they can do the operation correctly. For this reason, poorly designed accounting procedures, which permit inaccurate data to be processed, can result in extremely costly machine delays.

A final limitation of some computers is their high cost. The large-scale machines mentioned earlier cost in the neighborhood of $300 to $500 per hour to operate. Because of this it is not economical to perform certain operations on electronic computers. For example, sorting often cannot be justified on the basis of costs, or savings. This operation is so simple, and ties up the computer for so long a time, that the cost is usually way out of line with the sorting of the information outside the computer on punched cards. The high cost of putting an application on a computer also makes most nonrepetitive operations too costly for these machines. In other words, an electronic computer is capable of carrying out at extremely high speeds very complicated operations. When such operations are performed many times, that is, when the volume is high, a computer can be economical. However, when an operation is very simple in terms of the capabilities of a computer, like sorting, or when it is a nonrepetitive operation, like an exception, the application may very well not be economical on a computer. **s/p/a**

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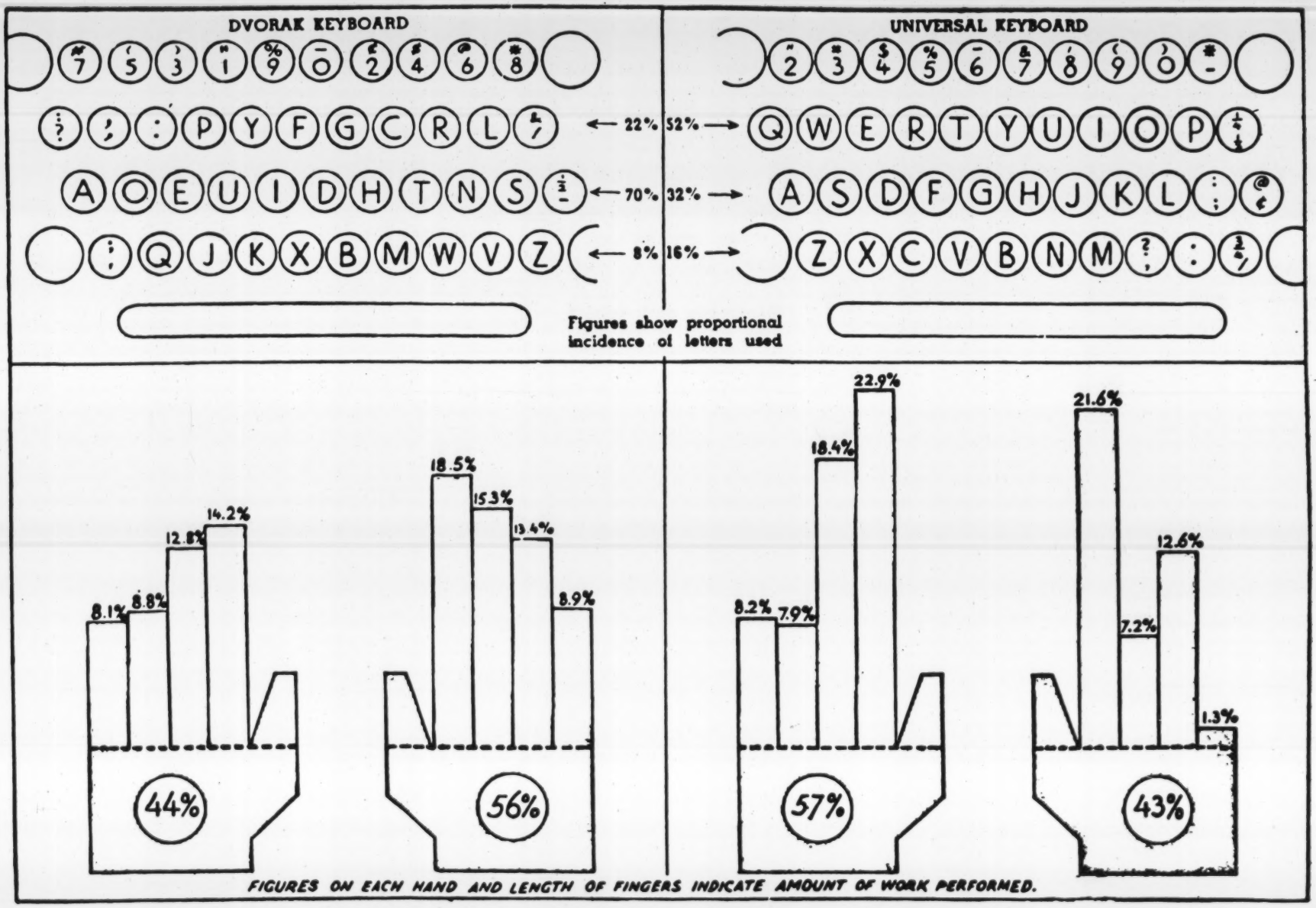

Comparative row, hand, and finger typing-loads on the New Simplified and on the old "Universal" typewriter keyboards.

THE DSK *and the Systems Profession*

by Thomas S. Booz and Richard W. Pomeroy

RECENT PUBLICITY attending the General Services Administration tests of the Dvorak Simplified Typewriter Keyboard has triggered a substantial amount of comment in ever-widening circles on the pros and cons of the new keyboard. As systems personnel primarily concerned with the betterment of the industrial profit picture, it would seem that a closer look at this proposed change to the most prevalent office machine would be in order.

The present keyboard arrangement is basically unchanged from the keyboard of the prototype machine invented by Christopher Latham Sholes in 1873, and marketed two years later by the Remington Arms Company. In laying out the keyboard, the inventor was faced with a problem quite alien to today's technology—if the keys were struck in quick succession, the typebars (arranged in a circle directly beneath the platen and returned to position by gravity alone) would jam. To overcome this condition Sholes placed letters which occurred in combination most frequently in different quadrants of the typebar circle. Obviously he was not concerned with the requirements of the then non-existent typist; Sholes expected his machine to be used in a hunt-and-peck manner.

This original inefficient layout of the keyboard has given rise to a curious condition: While it is generally agreed that the arrangement of letters on the keyboard is cumbersome, hard to learn, conducive to errors and fatiguing to use, it is the only aspect of the typewriter which has successfully resisted change. The reason for this is inherent in the universal use of the typewriter—too many people affected, too much upheaval to change.

There have in years past been dozens of proposals for modification of the Sholes keyboard; until recent years none has occasioned more than a passing interest.

The Dvorak Simplified Keyboard (DSK) was invented and patented by Dr. August Dvorak, formerly Director of Educational Research, and Director of the Carnegie Foundation Investigation in Typewriting at the University of Washington.

In 1925 Dr. Dvorak began studies of the standard keyboard based on the principles of motion study set forth by Dr. Frank Gilbreth. Interest at that time was in why (as Frederick G. Nichols, Dean of the Harvard Graduate School of Education, later put it) "Typing takes more time for less result than any other course in the curriculum." The end result of these studies was the Dvorak Simplified Keyboard, the best of more than 250 key arrangements, scientifically tested to overcome the shortcomings of the standard typewriter keyboard.

Dvorak, like others before him, put the most frequently used keys on the "home row" but he was the first to recognize that it is the time it takes to travel between strokes rather than the speed with which the keys are struck that controls output. By putting the vowels under the left hand and the most-used consonants under the right, he lets the two hands alternate most of the strokes on the home row, the fastest and easiest combination. In the time a DSK operator saves in travelling between rows on the simplified keyboard, she can stroke 54% more keys

than her counterpart on the standard (Sholes) keyboard. But the most important gain was that it cut the jumping around by 90%; and it is jumping, not spelling, that causes most typing errors.

The accompanying figure shows the Dvorak and standard keyboards and the relative loads on each of the eight fingers. Note particularly the heavier load on the normally weaker left hand and the unequal and irrational loads on all fingers in the standard keyboard. The revised keyboard shifts the heavier burden to the stronger hand and distributes it in proportion to the strength and agility of the fingers. The assembly of all vowels and most-used consonants on the home row permits the typing of over 3000 words on the home row compared with 57 words for the standard keyboard.

The Dvorak Keyboard has been conclusively proven to be easier to learn than the standard keyboard. Repeated tests have demonstrated that the DSK takes less than half as much time to learn. Typing is faster on the DSK; test results indicate that a 54% increase in speed can be achieved by the average typist. This figure however is misleading because the less proficient typist will reap a far higher percentage increase than her competent counterpart. This fact is important—it is the poor typist who is both problematic and prevalent. The average speed of present day typists is far below the figure which should be expected, and the increasingly acute shortage of trained typists tends to lower it continually.

By far the most important aspect of the DSK is the reduction of errors. By eliminating awkward finger movements, errors are reduced 70%. The standard for measuring typing speed is Net Words Per Minute, computed by deducting a penalty of ten words for each error from the Gross Words Per Minute. This suggests that in practice it would take about the same time to correct a typing error as it takes to write ten words. Certainly this is not true. It has been stated that it takes as much time per carbon to correct an error as it takes to write two complete lines. Some errors require retyping of complete pages.

Thus, a part of the benefit attaching to the reduction of errors is obscured in the accepted performance standard of NWPM which fails to penalize realistically for errors. Two typists may both be rated at 45 NWPM, but where one may have made one error in a test, the other, typing far faster, may have made 20.

Reduction of typing fatigue is an important by-product of the DSK. One need only to watch a typist at work to see that as the fingers move from row to row, the entire arm moves as well; it is estimated that this movement involves lifting a weight of 6½ pounds. To err on the conservative side, we may consider that the movement of the fingers from one row to another involves moving a weight of 5 pounds and that 2½ such movements are involved in typing a word. If a typist works at 50 wpm steadily for one hour she types 3000 words, or 21000 words in a 7 hour period, during which time she shifts rows 52,500 times. Multiplying this by 5 pounds per shift gives 262,500 pounds or 131 tons moved in a day's work. The DSK cuts this by 70% to a total of 39.3 tons. The result is that an operator switching from a standard keyboard to a DSK feels an appreciable reduction in fatigue at the end of the work day. This reduction of effort is reflected in the normal day's work by a willingness on the part of many retrained typists to work harder than before and take fewer diversion breaks.

The Dvorak Keyboard has for some time been in limited use and was tested in 1944 by the Navy. Fourteen typists representing a wide range of abilities and experience were given 83 hours of retraining instruction at two hours a day. The results were encouraging: an average gain in NWPM of 74% largely due to a reduction of errors of 68%. The report which resulted from these tests contains the following statement:

> "Such a training applied to the poorer 60% of Navy Department typists would, through the value of the increased typing proficiency, amortize the cost of the programs in about 10 days of full employment after the typists were retrained. By comparison, typists in the 'continuation' or 'refresher' typing classes require from 60 to 166 working days to amortize the cost of the training. Simplified Keyboard retraining is three times as valuable as is 'refresher' training on the Standard Keyboard when the value of the increased typing production on the two keyboards is calculated in the subsequent first eight months employment ($1,012.32 vs $357.42). In the first four months employment, because of the greater cost of Standard Keyboard 'refresher' training, the ratio is 4:1 in favor of the Simplified Keyboard."

It is conservative practice in the systems field to refuse any proposed innovation the cost of which cannot be amortized over a two or three-year period. The above statement is strong evidence that from a purely economic standpoint the new keyboard could be installed and an operator retrained at an investment which would be returned in not much more than two months.

The DSK has been subjected to the tests of competition. In the International Typewriting Contests from 1933 to 1941 students from Dvorak's classes, using different makes of typewriters equipped with the DSK, competed against the outstanding typists selected each year from approximately a million student typists in the United States. In nine contests DSK typists successively set 26 International Records; won 45 first places, 115 first, second and third places; four grand championships and four times won the Stowell Trophy for fastest dictating machine transcription. One 16-year-old girl set a world

record for high school students of 128 words a minute. Dr. Dvorak's star pupil, Lenore Fenton MacLain, "the world's fastest secretary," types consistently at 165 words a minute—much faster than the world record on the standard keyboard.

Based on the results of repeated tests which have been conducted over a period of years, it is estimated that the total impact on the American economy of the general adoption of the new keyboard would be a saving in the order of $2½ billion a year. Proponents of the DSK also foresee far-reaching intangible benefits accruing to the change: the use of millions of convenience typewriters in homes and offices, the improvement of students' marks (this is backed up by studies which show that students who type get higher grades than those who do not), higher typists' salaries, an adequate supply of competent typists as well as a substantial assist to the growing teacher shortage, and a two-fold increase in the demand for typewriters through wider application and heavier use.

It would seem after the above that a strong case could be built for the opponents of the DSK, but here a curious condition emerges. Dr. Dvorak wrote in 1943, "Past and current discussions regarding the Simplified Keyboard have provoked no objections based on technical considerations. There seems to be general agreement by all who have analyzed the facts that the Simplified Keyboard is (a) scientifically arranged; (b) easy to master; (c) less fatiguing to operators; and (d) conducive to greater operator accuracy. . ."

What then is holding up this important innovation?

Certainly the DSK has its share of opposition. Recommendations which resulted from the Navy tests were abandoned because of "administrative difficulties" which would result from such a move in wartime. Tests have been conducted by a number of small companies which reported that turnover and the lack of a continuing supply of DSK typists have defeated the programs. This suggests that a successful change from the old to the new system cannot be easily accomplished without also setting up a source of supply, i.e., schools turning out trained DSK operators. But the schools are reluctant to put scarce funds and scarcer teachers into turning out typists who may be discriminated against because they require a different typewriter keyboard. Another and very important factor of opposition is the nation's 2½ million people who type for a living and who oppose the new keyboard through normal human resistance to change.

Perhaps the main factor retarding the use of the DSK is the lack of knowledge and apathy of the men of our own profession. Certainly without the specialized knowledge and talent of systems personnel, the recent generation of a "Second Industrial Revolution" in integrated and electronic data handling, to cite an analogy, would have been delayed for years if not indefinitely.

Texts in the systems field have been almost devoid of mention of the DSK. One (Barish) does mention a few of the advantages of the DSK but does not explain it, and one author of an authoritative systems text goes so far as to say that the keyboards of all office machines are designed for optimum operator efficiency. In the methods field, Barnes, *Motion and Time Study* presents a more detailed treatment.

A growing amount of interest is being generated in the DSK through the GSA tests. But one thing should be pointed out: retraining of standard keyboard typists without steps to insure an adequate continuing supply of DSK operators is an oversimplified approach to the problem. Steps must be taken to set up training courses in educational institutions to assure this supply and make up for the loss due to normal attrition and even to increased attrition arising from the ability of DSK typists to obtain better jobs. Once the schools start supplying, three years' turnover will probably make the standard keyboard the exception.

The payment of an incentive bonus to typists might go far toward furthering the change. One large firm putting an ad in the newspapers similar to the following might foster the largest single systems improvement in the history of the systems profession:

> The United Manufacturing Corporation will accept typists trained on either the Standard or Simplified keyboard and will pay a 10% bonus to anyone averaging 75 nwpm for a half-hour test or a 25% bonus to anyone averaging 90 nwpm for a one-hour test.

The general acceptance of integrated data processing methods has placed an unprecedented emphasis on the accuracy of initial transcription of data which will determine the accuracy of all further documents and statistics produced therefrom. Millions of dollars have gone into this fight against errors; the DSK might supply powerful assistance in this battle. **s/p/a**

Thomas S. Booz, Jr., born in the Canal Zone, was educated at Pomona College, Northwestern University, Boston University (MBA), and attended the Advanced Management Program at Harvard. In over 20 years of systems work he has worked as an accountant, auditor, purchasing agent, production and tool engineer, and company comptroller. He is now employed as a systems man for the Davidson Dual-Lith Co.

Richard W. Pomeroy was educated at Columbia and New York Universities. Formerly with the General Electric Co. and the Otis Elevator Co. as systems man and Inventory Controller, he is now on the staff of Fairbanks Associates, Management Consultants, Greenwich, Conn.

1. *The clerical work of the company is spread throughout the organization and is under the control of a number of department heads.*

2. *In order to carry out a thorough study the terms of reference of the group must enable them to examine all phases of the business and they must have sufficient status to assure their acceptance.*

3. *Use every public relations gimmick you know to get the study off to a good start.*

4. *Clerical systems should not be analyzed as a number of water-tight compartments—with possible changes limited to the confines of each compartment.*

5. *To take best advantages of new procedures it may be necessary to recommend broad organizational changes.*

6. *In evaluating an existing system try to separate the inadequacy of the system from any maladministration.*

7. *Keep the reports as condensed as possible and rewrite and rewrite until you are convinced that they SELL your ideas.*

8. *Take a breather after the changes are made to see if the proposals stood the light of day.*

The Functions

From an Address

QUITE FREQUENTLY when business people refer to clerical work they are considering only the work performed by the so-called office staff and no more. While these indivduals may be the only ones who are occupied entirely with clerical work, they do not account for all the clerical work in the company. Far from it. It is my contention that, for systems purposes, clerical work includes the activities of all individuals engaged in processing paperwork anywhere in the company. This is true even though some of these people may be engaged clerically only a minority of their time.

One pertinent characteristic of clerical work is that it usually occurs—to varying degrees—in every department of the business. It certainly is not confined to a group reporting to an Office Manager.

We are all aware of the usual and necessary clerical functions such as general and cost accounting, cash receipts and disbursement, payrolls, etc., that normally are supervised by the Office Manager. For a moment, let's consider the sort of clerical tasks over which he may assert little or no control.

In the Purchasing Department there are the duties connected with the issuance of purchase orders and subsequent expediting and record keeping. In the Personnel Department, employee records and certain statistics are accumulated. There may exist a separate tabulating and statistical section. The sales department may operate an order desk, prepare price lists and catalogues. Even the salesman writing orders in the field forms a part of the clerical group. In the factory we may have a factory office. Shipping, Receiving and Stores-keeping have a large clerical element. Much of the work in Estimating and Production Control is clerical. Even production workers get into the act when they prepare time and production reports.

by K. G. Belbeck

of a Clerical Systems Group

Prepared for Delivery at the Toronto Chapter of SPA

If you reflect soberly on the clerical work of a company, it becomes apparent that it exists in almost every nook and cranny. It is performed by people who report eventually to a number of department heads. And many of these department heads do not feel that clerical methods are among their prime responsibilities.

From some short studies we have made among industrial organization, we estimate that for every $1.00 paid to the conventional "white collar" clerical worker, at least an additional 40 cents is paid to other individuals in the organization for the performance of what is essentially clerical work.

I'm not suggesting that this is wrong or undesirable. The point I'm trying to put across is that when we think of the clerical work force, we must not consider it as simply the group of girls sitting at rows of desks in the front office—although they may account for the biggest portion of clerical work (and the best scenery) in the company.

Another characteristic of clerical work is that it has a tendency to flow from one organizational unit to another. In other words, a typical business transaction sets off a chain reaction that involves a number of departments. Consider buying and paying for something. There is clerical work performed in at least—

- — The requisitioning department
- — Purchasing
- — Traffic
- — Receiving
- — Stores
- — Accounts Payable
- — Cash Disbursement
- — Statistics
- — and perhaps others.

Dun's Review of Modern Industry puts the problem very well. If you'll excuse me, I'll quote directly from it:

> "One reason for the inefficiency of office procedures is that practically no paperwork begins and ends in the office. Most paperwork starts somewhere else, passes several departments and affects finance, production and sales, plus record-keeping functions. Because he isn't in a position to cross departmental lines, the Office Manager cannot recommend broad procedural changes that are needed. And the executive he reports to usually concentrates on another major area of responsibility."

In our opinion, a clerical systems study which is confined to the classical limits of "The Office" has two strikes against it before it starts. The best it could hope for is simply to polish up the existing general procedures while missing the real pay-dirt that awaits a company-wide review.

It follows, then, that any clerical systems study that is worth its salt is going to cut across a number of departmental lines. The resulting recommendations may involve rather extensive organizational changes.

Furthermore, clerical work is often held up as an example of flagrant inefficiency. While such criticisms may be perfectly in order, there are a number of factors which tend to contribute towards low clerical efficiency.

Primarily, the bulk of the clerical force is composed of girls and young women who are not necessarily eager for promotion. In fact, many of them have their own retirement plan and intend to make it operative as soon as they can get the young fellow to see it their way.

In recent years, manufacturing activities have been scrutinized by methods people—better methods have been developed—production goals established for workers, and so forth. But generally speaking, no such organized effort has been put forth towards clerical efforts. So,

quite naturally, they suffer by comparison. Moreover, little effort has been focused on the training of clerical supervisors.

Up to this point I have attempted to establish the characteristics of the clerical activity in a company. In summary, this is it. It is a sizable portion of the total payroll—often more than we realize. The individuals comprising it work under a number of department heads who have varying degrees of interest in clerical performance. The force consists largely of young women and—although it varies from company to company—it is generally less efficient than the manufacturing operations.

Terms of Reference

Now we are ready to consider our original question, "What are the terms of reference of a clerical systems group?" Of course, this will vary from situation to situation, but in a general way perhaps this will sum it up:

> "To investigate all spheres of clerical activity—regardless of what organizational unit the work is performed in—and to analyze it critically from an overall company point-of-view. Then, to propose revised procedures—and indeed revised organization if necessary—that will result in the performance of all *necessary* clerical functions at optimum cost to the company."

The terms may also be expanded to include guiding approved plans through the installation phase and subsequent follow-up studies.

Composition of Systems Group

Having established the terms of reference, our next problem is, "Who are to comprise the group and to whom do they report?"

Organizationally, setting up a clerical systems group is more difficult than, say, a manufacturing methods group. In a factory situation nearly all changes that may be made will come under one department head—the Manufacturing Manager—so the group can be a technical one and report directly to him. However, the same convenient circumstances do not exist for the clerical systems group. As I have pointed out, they will have to deal with a number of department heads, each of whom reports directly to general management.

Because of the importance of the clerical systems job and also because of the organization problems involved, a Clerical Systems Group ideally should receive their instructions from and report to general management.

General Management, however, may not care to roll up its sleeves and get involved in the day-to-day detail of such a study. It may prefer to pass that portion of the job on to a group. And wisely picked, the group should represent the departments in which rests the majority of the clerical work, with perhaps the Treasurer or Comptroller as Chairman. A group so constituted has several advantages. A broader point-of-view is brought to bear on the problems. Perhaps more important, recommendations which are finally put forward will already have at least partial acceptance in the departments concerned. This, of course, will make subsequent installation much easier. In fact, it may make the difference between success and failure.

Before I get carried away talking about a "systems group" let me clarify one point. It is by no means necessary to turn a large group of people to studying clerical routines and systems in our hypothetical company—unless the house is on fire. So far as the actual study and investigation are concerned, once he gets rolling, one competent investigator can probably come up with recommendations far faster than the organization can handle them.

The main point in establishing a group is to raise it above the single department level and give the project some status. There are other ways of obtaining this effect. You can have outside individuals such as your auditors or consultants sit as permanent or occasional members of the group. In some instances representatives of office equipment manufacturers may sit in.

The individual who is going to carry out the actual systems study will naturally be a member of the group. However, identifying such a person is not always a simple task. You may find someone in the Comptroller's or Treasurer's department. He would likely have a good grasp of the technical requirements. More important than this however are an impartial attitude and an active imagination. The Industrial Engineer, even though he has never been out of the factory, is a pretty good bet. His training and experience have taught him to approach every situation with a critical and imaginative mind. With a little help on the technical details he could do a good job. Many companies who cannot either find or release a man to do the job rely upon consultants to carry out the actual investigation.

A Word of Caution

We whose work it is to develop systems and procedures share the same occupational hazard—we almost always want to change the present procedure for something which we feel is better. Whenever we view an operation that is far from efficient, we set straight away to develop an apparently more streamlined approach. And therein lies a real danger.

It is imperative that before we seriously consider any recommendations proposing a change in the system, we ask ourselves this question. "Is it the present system

itself that is at fault or is it the *administration* of the present system that is at fault". And dependent upon the answer, the possible courses of action are entirely different.

A recent American Management Association publication illustrated the point very well. Here is the example.

> "It is 1948: method A is in use: the annual cost is $100,000. An engineer proposes a change to method B to reduce the annual cost to $75,000. (The charges for making the change are only $6,000 so it looks like a good return on investment). The executive approves the change.
>
> It is 1951. Method B has been in effect for more than two years. The annual cost is now $88,000 (not as low as the $75,000 anticipated but a good reduction from $100,000 just the same-. Now comes the second engineer. He proposes a change to method C, to reduce the annual cost from $88,000 to $74,000. (The cost of making the change will be only $5,000.) The executive studies the proposition and suddenly starts. The proposed method C is nothing more than the original method A! Can one save money both ways? Absolutely, with one catch. There is only one thing wrong with the figures. Each engineer presented the then existing method at the *going* level of effectiveness Each engineer also presented his proposed method at its *optimum* level of effectiveness. Neither engineer had presented data to show what could be done with the then existing method under improved administration; neither engineer had realized that if poor administration is rampant, the optimum effectiveness will never be reached, no matter what the method."

I think it would do us all some good if we re-read this about once a month.

What's Important?

One alarming characteristic of many clerical systems is that they are set up to process all data with the same degree of detail or precision without regard to the significance of the data. In other words, we fail to separate the trivial from the vital and consequently spend far too much money controlling things that can have only a small effect on profit.

Pareto's Law sets forth the principle very concisely.

> "In any series of elements to be controlled, a selected fraction, in term of number of elements, always accounts for a large fraction, in terms of results."

For example, there may exist ten thousand different catalogue items in an inventory. It is almost always true that the first few percent of those ten thousand items will account for perhaps 80 per cent of the total value of the inventory. In the same way a few percent of the total employees on the payroll account for the bulk of the personnel headaches, accidents, suggestions, etc.

If a clerical systems investigator keeps this principle in mind he will reap a rich harvest. For example, in a recent study made by a member of our firm we found a situation like this. The company was a fairly small one, but it had a relatively large inventory of purchased parts. Kardex records were maintained on every item in stores regardless of their value. However an analysis of the inventory showed that 70% of all the records controlled only 10% of the value of the inventory. The total value of the inventory was about $50,000. Therefore 70% of the labour expended in record keeping was controlling only $5,000 of inventory.

By discontinuing to keep records on this relatively unimportant section of the inventory one and one half fewer posting clerks were required.

By failing to separate the trivial from the vital the company was paying out roughly $2,500 per year to keep records on $5,000 of inventory.

Mechanization

The word "Mechanization" is used today by executives with the same anticipation that Ali Baba had when he shouted "Open Sesame". However, unlike Ali Baba, the modern executive is often disappointed. I'm not here to speak out against mechanization of clerical operations in general. In many instances the result is quite rewarding. Indeed, we often strongly recommend mechanization of certain clerical areas or functions. The problems —and the disappointments—occur when management attempts a half-hearted job. They may insist upon mechanizing the present system—just as it exists—no changes in organization or related procedures are permitted. The instructions are handed down simply to replace the work presently done by as few machines and operators as possible.

This approach misses two important areas of savings:

1. The machines themeselves may not be ideally suited to the operation as it is presently set up but can obtain the end result economically using a different procedure.
2. Also because of the capabilities of the machines they may be able to perform simultaneously, or with a minimum of extra effort, jobs that are being done in other areas.

Producers of electronic data processing equipment are running into this every day. Large companies are sending men to programming courses with instructions like this, "See if the machine will fit into our way of doing things—with no changes in procedures or organization." These people might just as well stay at home.

My point is that when considering office mechanization—be it a simple posting machine or a giant digital

computer—don't simply try to fit it into portions of the clerical work as it is presently arranged. Once in a long time that may work well. More often, however, greater gains can be made by taking a bird's eye view of *all* clerical functions. This involves studying the flow of data from the moment it is created—be it by the production worker, the salesman, or anyone else—until it is disposed of. It involves critically analyzing the company's *total* clerical requirements and arranging them to take full advantage of office machinery. What I am talking about here is a complete systems integration—getting the work done most effectively and economically, regardless of who does it.

When the systems group gets into the detailed area of choosing a specific machine or machines they may have some difficulty—especially if they are not well acquainted with the field. It is difficult to judge the relative superiority of a given machine because direct comparison between machines is very difficult. Many people rely upon the advice of manufacures' representatives. And I have seldom heard a machine Salesman claim anything for his machine that it would not do. However, if they have a shortcoming it is in failing to mention what the machine will *not* do.

There are several ways in which the group can get assistance. They can check with other firms who are using equipment in a manner similar to that contemplated. If it is a big installation you may be able to get a machine on loan to process a sample of your work.

Evaluating Proposals

As the systems group completes its investigation and starts synthesizing new systems, it become necessary to evaluate the effects—be they economies or improved operations or both. At this point it is important to be extremely honest with yourself. We are all proud of anything we develop and it's only natural to attempt to show it in a good light.

However, all too frequently savings are quoted to justify a change when the savings are not wholly attributable to the change. Here is an actual example of what I mean.

The comptroller of a company with whom we were working came up with a plan to change his accounts receivable procedure. Up to this time receivables had been processed on conventional posting machines preparing ledger record, statement and journal simultaneously. However the breakdown of work was a bit illogical and there were more people kicking around the department than was necessary. The proposal was to scrap the machines and use a system of open ledgers using copies of invoices as accounts receivable records. This, of course, is not an uncommon practice. When the change was made there would no longer be any statements sent out (since the new system did not provide for their being prepared except by hand at the end of the month). He re-arranged the duties considerably and forecast that a reduction of so many dollars a year would be effected. He used these savings to justify the investment in the rather elaborate filing equipment necessary. The whole proposal looked very rosy.

However, the truth was that many of the savings being contemplated could have been effected within the present system. For example, the discontinuance of statements and the re-arrangement of duties were not dependent upon throwing out the machines. In the final analysis the savings that could actually be attributed to the new system could justify the new equipment, but the correct savings were shockingly smaller.

What he was doing, of course, was lumping the economies of the new system with the economies of better administration, both of which he planned to introduce simultaneously.

Report to Management

When the study and synthesis are completed the next big task facing the systems group is the preparation of its recommendations for presentation to management.

According to historian Jacques Barzun, "English is no-one's mother tongue, it has to be worked for". And how right he was.

We probably all enjoy digging out the facts and formulating new ideas for systems and procedures. But when we sit down to express them clearly and concisely, we face a mental roadblock. However, it's something we must struggle with, no matter how painful and time-consuming it is. The results of all your work up to this point may depend upon how convincingly you present your arguments. I suggest that a good many of the ideas that exist in the minds of business people are never adopted because they fail to communicate them properly.

What form the report should take is up to the writer in many respects. I think the important thing is to study the way the person who is to receive the report works and thinks—and tailor the report accordingly.

Only in rare instances are lengthy reports desirable. Those of you who are accustomed to speaking know that it is easier to talk for an hour than for fifteen minutes on a given subject. If you hold the floor for an hour you can ramble all over and be pretty certain that you have covered the subject. But to do justice to the subject in 15 minutes is a more difficult task. Similarly, putting all the meat of an investigation into a short report is a tough job. It involves boiling down, re-arranging, boiling down some more, and so on. It's painful, but it's worth it.

There are probably an infinite number of reasons why reports fail to stir management to action. Here are a few of them.

1. The report suggests—whether it's true or not—that insufficient investigation has been made of all the possible ramifications of the problem. That is, that the study was only a superficial one.
2. The future growth of the company or other possible changes have been inadequately provided for—the group has had its nose too close to the grindstone.
3. The proposals may appear to be stop-gaps—or may appear to be the easy way out of a tough situation.

What Should Report Contain?

In a general way, what should a report on a clerical systems study contain?

1. A brief outline of the principle of the proposed systems or procedure. Too much detail here may not only swamp the reader but may get subsequent discussions a long way off the track.
2. A summary of any organization changes necessary, and a frank discussion of problems which may be encountered in carrying them out.
3. A fair outline of the cost of the project—not only the orginal investment in equipment and forms but the initial installation cost and the subsequent annual charge.
4. What are the gains? They may not be just reduced costs. Spell out the others no matter how obvious they may be—better reports, improved working conditions, better service to customers, etc.
5. The section most frequently left out of a report is how to get the job done. A positive plan is required here. Who should do the job? How long will it take? When should the various stages be completed?

Not Always Open-Minded

There is one other problem in making recommendations regarding clerical systems. Managements are accustomed to thinking big in terms of investments in machines which will improve the product, reduce costs, etc. However they are not always as open-minded in considering expense involved in improving systems and procedures—even though the rewards may be just as big. It is sometimes helpful to calculate the return on investment in systems changes just as you would on capital expenditures and include that in the report.

Getting Proposals Implemented

Once the reports have been submitted and approved, who is to carry out the accepted plans? This, of course, will vary with the circumstances. However, generally speaking, the people who have done the investigation work are ideally suited to guide, co-ordinate and direct the program, even though it may be certain line supervisors who have ultimate responsibility for actually effecting the changes.

The Follow-up

The last phase of any systems program is the most easy to overlook—the follow-up. Quite frequently everyone is too busy making things work to compare how the actual results stacked up with what was expected. However, it's quite often a revealing—and sobering—experience. If the systems group that carried out the study is given the task of reviewing the results a couple of desirable things may happen.

Sadder but Wiser

They may end up a sadder but wiser group and subsequent studies may reflect the lessons they learn.

They may also detect areas where the original plans are not being followed.

Complex Problem

Well, there you have it—a rather condensed story of the functions of a clerical systems group. There's no denying that it is a complex problem and I've only been able to scratch the surface. **s/p/a**

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Do they READ what you WRITE?

by Pauline Putnam

Partner in the Writing Clinic, San Francisco

THE READER IS IMPORTANT to anyone who writes. But it strikes me he's particularly important to systems and procedures work. For you have to reach him on at least two levels. You not only have to tell him what your systems and procedures are all about—in other words, sell him on them, persuade him to adopt them. But once he has adopted them, you have to translate them into written instructions for him to follow.

Yours is a double job—persuading, then telling "how". It's no exaggeration to say that you often succeed or fail in that job according to how well you talk to people on paper.

Business as a whole does tend to forget the reader when it writes. Somehow whenever it puts pencil to paper it seems to suck in its breath, puff out its chest, and deliver itself of things like this:

> Should the supply of forms sent you not be sufficient to meet your requirements, application should be made to the undersigned for additional copies desired.

When all it really means is this:

> If you need more forms, let me know.

It is not technical language that I'm gunning for. Every field has its technical terms, and quite properly so. You, for instance, could hardly talk or write to one another without terms like "data processing", "electronic computer", or "quarterly journal entry."

As long as *you* know what you mean by those terms, and as long as you use them *only* when you are talking or writing to one another (as long as you're careful not to sledge-hammer the layman with them) there's no harm done.

What I'm gunning for, on behalf of your reader, is the language *around* those technical terms. Because that is where the real trouble lies, no matter who your reader is—insider or outsider.

So what about that language? Is it as simple and direct and readable as it could be? Or are you unconsciously flossing it up to make your subject sound important?

Interesting Comments on Simplifying Your Writing So It Can Be Read Easily — from an Address Given at the San Francisco SPA Chapter

If you *are* flossing it up, you're losing readers right and left. That I can promise you. For the modern reader is a restless creature. He reads only when he has to—and then usually on the run. Unless you convey your meaning to him fast, as he races by, you may not convey it at all. Or you may only half-convey it. And then what becomes of all the efficient systems and procedures you hoped to put across!

Let's take a closer look at this flossy language. Maybe if we know some of its symptoms we'll be better able to spot it in our own writing, and cure it.

When a writer has forgotten his reader, and is waxing flossy, he invariably reaches for the roundabout phrase instead of the single word that would do as well.

> Instead of asking someone to *consider* a plan, he asks him to *give consideration to* it.
>
> Instead of urging that a certain procedure will save $10,000, he says it will *produce a savings*, or *result in a savings*, or *realize* a savings, or *effect a savings of* $10,000.

Not content with roundabout verbs like these, he will toss in some roundabout prepositions, too:

> Instead of telling the reader what happened *before* a meeting, he tells him what happened *prior to* it.
>
> Instead of writing to him *about* a certain procedure, he writes *with reference to* it, or *with regard to* it, or *in connection with* it.

Roundabouts like these waste everybody's time—the writer's, his secretary's *and* his reader's.

As for the money they waste, I leave that for you to figure. I only know that the waste must be enormous when a piece of writing is twice as long as it needs to be . . . when it takes the writer twice as long to write . . . his secretary twice as long to copy . . . his reader twice as long to read.

When you add to that the fact that the reader may never read it at all, that he may be so befuddled by all those words that he just gives up or only half-registers what they mean; and when you add to that the fact that such writing goes on in every department of a business, day in and day out, on hundreds if not thousands of sheets of paper—well, the cost of writing like that must be simply staggering!

Too many words are not the only sign of the writer who has forgotten his reader. Another sign is words that are *too long.*

I said "*long*", not "*big*" on purpose, because I don't want you to think I'm trying in any way to limit the vocabulary you've been building up all these years. Everyone who writes can do with plenty of words at his command. And if you have a bundle of big ones you can call on by all means go ahead and use them. (Though you'd better go cautiously when you do. You'd better be sure your reader understands them too, or he'll resent you for showing off, putting on the dog.)

It's not big words, in the sense of rare words, that I'm after today. It's long words: words we all understand perfectly well, words like *objective, participate, assistance, additional, utilize.*

Why are they so bad in writing?

They're not bad if you use them sparingly, one here and another there. It's only when you let them take over your writing entirely that you begin to weigh it down, make it hard to read, and eventually kill off your reader.

The point is, these long words are all very formal words, would-be elegant words, slightly pompous words. Most of them are imports from Latin and Greek. We rarely use them when we talk to one another. It's only when we write that we begin to reach for them. And the oftener we reach, the sooner we lose our reader.

People read easily a piece of writing that talks right to them . . . that reproduces (not exactly, but more or less) the sound of the human voice . . . that recreates the author, sitting there across the desk from them, chatting about his subject easily and informally. The minute we, as writers, start reaching for words that don't sound

like us *talking*, we put barriers between ourselves and the reader. We sound distant, remote, unconcerned.

What about the words you choose when you write? Are they always the long ones? Or are you still able most of the time to use the good, plain, short ones—the ones that sound like you, talking?

For instance:

> Do you tell him to *discontinue the distribution* of a certain instruction—or just *stop sending it out?*
>
> Do you promise to *advise him of future developments*—or just *let him know what happens?*
>
> Do you tell him you want to *effect certain modifications* in a procedure, *contingent upon the concurrence of management*—or simply that you want to *change it if management agrees?*

It would be hardly surprising if you found yourselves writing pompous doubletalk like this. It is the normal language of business these days.

Write Efficiently

But you, of all people, concerned as you are with the most efficient ways of doing things, should write simply, clearly, directly—in other words, efficiently. You should talk *to* the reader in the language he is most apt to read and understand fast.

When you write an instruction, instead of telling the reader that

> Form 2642 shall be rendered even though no direct shipment transactions occurred

talk *to* him, as one human being to another, and tell him to

> Fill out Form 2642 even though there were no direct shipments.

Even when you're not giving the reader instructions, keep talking *to* him. Insead of telling him that a computer can process data

> at speeds far in excess of the ability of the machine to read in new data or print out fully-processed data

tell him that it can process data

> much faster than it can read them in or print them out.

As a matter of fact, it's when you are writing *about* systems and procedures that you should be most on your guard. It's then, even more than when you are writing instructions, that you may be tempted to let words run away with you. Here, for instance, is a writer completely carried away wih his words, and the longer they are the better:

> Any evaluation of a proposal for changed methods or new mechanical or electronic equipment must assemble for consideration the known limitations inherent in the proposal. We are presently at a distinct disadvantage inasmuch as the field of past experience in business applications of electronics has been restricted to such a brief period. However, there has been sufficient exposure to the problems in its pioneering stages to pinpoint some areas of limitations. A few of these limitations are factors to be considered after the decision has been made to acquire such a system.

All the writer really means, I suppose, and all he would have said if he had been *talking* to the reader, is this:

> When we decide to take on a new electronic system, we ought to consider its limitations. We don't know all of them yet because we haven't used electronics in business very long. But we *can* pinpoint some of them. And those we ought to look into carefully.

A reader listens when you talk to him that way on paper. He gets what you're after at a glance: first, because you use the short straightforward words of speech; second, because you use only half as many words (in this case, 47 instead of 92).

I admit it isn't easy to write this way. In the first place, you have to know exactly what you mean—and how many of us are ever that lucky? Then, even if you do know what you mean, you have to fight off the perpetual impulse to dress it up. You still have to probe down through layer after layer of inflated words to find the shortest, clearest ones that will convey your meaning to the reader.

Write to the Reader

You even have to bring another sense into play—the sense of hearing. For when I urge you to write to the reader pretty much the way you would talk out loud to him, I'm urging you to do what all really professional writers do—write by ear instead of by eye.

It isn't easy. Because tradition and habit and lack of time all force you in the other direction—away from the reader and into fancy doubletalk. If you find you need help overcoming this tradition and habit, try reading some books. Rudolf Flesch has written some good ones: *The Art of Plain Talk* and *The Art of Readable Writing*. Robert Gunning has written one too: *The Technique of Clear Writing*.

If reading about writing isn't enough to jar you loose, give some thought to classes in clear writing—workshop classes, perhaps, set up as a regular part of your company's training program.

Whatever you do, protect what you write against the fatal reader-veto. You can't afford not to. **s/p/a**

USE STANDARDS FOR *Office Machines*

by Charles I. Keelan

OFFICE MACHINES should be purchased for one reason only: to reduce cost and thereby increase profits. Obviously, all office work could be done by people without machines. However, this would, at some point, become uneconomical. When we reach this point, we should purchase a machine. In other words, we should purchase machines when machines become less expensive than the people they replace. We can determine when machines are financially desirable (i.e., less expensive than people) by financial analysis.

We can do an analysis:

1. Prior to the purchase of a machine, or
2. To establish purchase standards which may be used in lieu of an individual analysis.

The first procedure is expensive and costly in analysts' salaries. Establish a set of standards for a kind of machine and you have to do only one analysis instead of an analysis every time a purchase is more advantageous.

We have now established two points:

1. Financial analysis of proposed purchases is desirable.
2. Analysis should produce a set of standards against which most proposals for purchase of office equipment may be measured.

As expenditures for most office machines are classified capital expenditures, it might be well to discuss for a moment the nature of capital expenditures. If an incorrect decision is made involving operating expenditure (e.g., to change a raw material), we may correct it by altering or revising the decision. But if we purchase a capital asset, we must live with it. There is one shining moment to make the correct decision, and that is when the proposal is being considered.

The best way to explain our method of establishing standards for office machines is to illustrate it by use of an example. For our example, let us use adding machines and assume that:

A manual adding machine costs $200
An electric adding machine costs $300
Maintenance of a manual machine is $15
Maintenance of an electric machine is $20
Both models have an engineering life of 10 years. (We use engineering life, not accounting life).
The salary of the average operator, including fringe benefits, is $2.00 per hour.

Let us assume that an average clerk equipped with a manual adder will produce 4 times as much work as with no machine (i.e., adding and subtracting without a machine); and if equipped with an electric machine, 5 times as much work as with no machine.

We shall assume that we demand a 10% return on capital expenditures. This is because we put out the money now but reap the benefit only over the life of the machine. This might be regarded as the payment we demand for the use of our funds.

Now for the problem. First we must determine the annual cost of the manual machine, i.e., the costs we would not incur if we did not purchase a machine.

The annual costs are:

Depreciation (based on engineering life of 10 years) ($200÷10)	$20
Maintenance	15
Return on investment ($200×10%)	20
Total annual cost	$55

In other words, if use of this machine saves us $55 per year it will be financially desirable to purchase it. An annual saving of $55 will give us our demanded return on investment and will pay the annual cost of the machine.

To convert money to time, we divide by the hourly rate of an average operator ($2.00).

$55÷$2=27.5 hrs./yr. or 6.6 mins./day

Must Save 6.6 Minutes

This means, use of a machine must save an operator 6.6 minutes per day to justify purchase.

If X = time to do work without adding machine

then $\frac{X}{4}$ = time to do same work on a manual adding machine (manual model is 4 times faster than hand work)

To determine how much time an operator must spend adding without a machine to save 6.6 mins./day by using a machine, we solve the following equation for X:

$$X - \frac{X}{4} = 6.6 \text{ mins./day}$$

$$X = 8.8 \text{ mins./day}$$

$$\frac{X}{4} = 2.2 \text{ mins./day}$$

We now know that a clerk adding and subtracting without a machine for 8.8 mins. per day will save 6.6 minutes per day if he is given a manual adding machine and, therefore, purchasing a machine for this clerk is financially desirable. We may also conclude that a clerk using a manual adder 2.2. minutes per day should be given another machine if his wears out, because the 2.2 mins./day on the machine is equivalent to adding and subtracting for 8.8 mins./day without a machine.

Our next step is to consider the electric adding machine. Here, we must compare the electric to the manual and determine when the greater speed of the electric will make it financially desirable. To make the comparison we concern ourselves only with the differences in cost and speed.

Additional Cost: $27

The additional costs of an electric machine over the manual are:

Depreciation (10 years) $30 - $20	$10
Maintenance ($20 - $15)	5
Electricity	2
Return on additional investment [10% X ($300 - $200)]	10
Total annual additional cost	$27

The greater speed of the electric over the manual machine must save us $27 annually to make purchase of the electric financially desirable.

To convert $27 to time, we divide by the average hourly rate of $2.00 which equals 13.5 hrs./year or 3.2 mins. per day.

Again, let X = time to do work without adding machine

then $\frac{X}{4}$ = time to do work on a manual adding machine

and $\frac{X}{5}$ = time to do same work on an electric machine

Solve for X:

$$\frac{X}{4} - \frac{X}{5} = 3.2 \text{ mins./day}$$

$$X = 64 \text{ mins./day} \quad \frac{X}{4} = 16 \text{ mins./day}$$

$$\frac{X}{5} = 12.8 \text{ mins./day}$$

Therefore, if a person adds (subtracts) without a machine for 64 minutes per day or adds for 16 minutes per day on a manual machine, it is economically wise to give him an electric adding machine, and, if he adds 12.8 minutes on an electric machine, we should replace it with another electric when it wears out.

Look at the Figures

Now let us take a jaundiced look at our figures. They tell us we should purchase a manual adding machine to save 6.6 minutes per day. Common sense tells us if we save a clerk 6.6 minutes per day, he will not, generally, use this small portion of time to do constructive work nor will his supervisor assign additional work for so short a period. We are in the indefensible position of recommending an expenditure for a machine that will result in a time saving but not in an increase in production. To obtain an increase in production attributable to a time saving machine, we must set a minimum time saving that is long enough to be used constructively by the clerk. We have arbitrarily set 30 minutes per day. Of course, if our costs required a time saving greater than 30 minutes, as in the case of the electric adder, we would use the greater time.

Now, we must determine the amount of adding without a machine that will result in a 30 minute time saving with the aid of a manual machine.

We solve our manual adding machine formula for X, but substitute 30 minutes for 6.6 minutes.

$$X - \frac{X}{4} = 30 \text{ minutes per day}$$

$$X = 40 \text{ minutes per day}$$

This is our standard for purchase of a manual machine.

Our standard for purchase of an electric machine is correct as computed, because the 64 minutes of adding without an adding machine will result in over 30 minutes of time saving with an electric machine.

Our final standards for purchase of an initial machine are:

If work being done without a machine amounts to 40 minutes per day, purchase of a manual model is indicated.

If work being done without a machine amounts to 64 minutes per day, purchase of an electric model is indicated.

Standards for replacement of lone machine:

If we now have a manual model:

Used less than 10 ($\frac{X}{4}=\frac{40}{4}=10$) minutes per day—no replacement advised.

Used more than 10 min./day, less than 16 ($\frac{X}{4}=\frac{64}{4}=16$) mins./day—replace in kind (manual model)

Used more than 16 minutes per day—replace with an electric model.

If we now have an electric model:

Used less than 8 ($\frac{X}{5}=\frac{40}{5}=8$) minutes per day— no replacement advised.

Used more than 8 mins/day, less than 12.8 ($\frac{X}{5}=\frac{64}{5}=12.8$) mins./day—replace with a manual model

Used more than 12.8 minutes per day—replace in kind (electric)

Not for One Clerk

Here we must make a point about administration of our standards. We do not recommend purchase of a time saving machine for an office with one clerk, nor for a person whose work load is fixed. Purchase of a time saving machine in these situations would only result in free time for the clerk and no advantages for the company. However, if purchase of a machine for a lone clerk would prevent, or delay for an appreciable time, the hiring of additional help, purchase may be desirable.

But we have only begun. The standards just developed apply where there is one machine and one operator. If you have two or more operators, there arises a new question: Should each operator have a machine or should they share a machine? Thus, our basic problem has changed. We no longer consider the waste due to hand operation, we must now consider the waste due to the inefficiency of sharing machines. When operators share machines, they receive the benefits of a mchine but they also will have another source of waste—conflict (simultaneous demands for the machine by more than one operator).

Of course, not all office machines lend themselves to sharing. The principal ones that do are: adding machines, calculators, and dictating machines. Duplicating machines not located in a central service department also may be shared.

When two or more persons use the same machine, there is bound to be some conflict. This conflict can be determined by heeding the laws of chance. If this conflict results in enough wasted time, the purchase of a machine becomes desirable, for another machine will reduce the waste due to conflict. The problem is to determine how much conflict will result in enough waste to warrant purchase of an additional machine.

But all conflict is not waste. While waiting for a machine, an operator may do other work or resort to hand calculations.

Sharing machines results in additional waste apart from conflict. That is travel to and from a shared machine.

We now have two factors: The one in the second preceding paragraph reduces waste and the one in the preceding paragraph increases waste. We assumed these two factors offset each other and that, therefore, conflict and waste are equal. We checked this assumption by actually timing and observing operators sharing machines and found that this assumption was substantially correct.

To compute the amount of usage that will result in enough conflict to make purchase of another machine desirable, we have derived the following formulas:

To derive these formulas or any workable formulas, we must assume all operators sharing a machine(s) use the machine(s) an equal amount of time. If we do not make this assumption, we would not be able to devise any formulas because the various combinations of usage per operator would approach infinity and obviate any formula. We have checked this assumption by working out problems and have found the resulting distortion very small. (Please note that this assumption will have to be accepted.)

Now for the formulas:

Let us take three operators (a, b, & c) sharing one machine:

Let A = proportion of day operator a demands machine

Let B = proportion of day operator b demands machine

Let C = proportion of day operator c demands machine

Let U = usage of any one operator

As we assumed all operators (a, b, & c in this case) use the machine equally, A, B, & C, will be equal to each other and to U (i.e., A=B=C=U).

The conditions possible with 3 persons and 1 machine are:

	Requires machine	*Do(es) not require machine*
No conflict	no operator	a, b, c
	a	b, c
	b	a, c
	c	a, b
conflict	a, b	c
	a, c	b
	b, c	a
	a, b, c	no one

The Formula

The formula for simultaneous demand (conflict) is:

$AB(1\text{-}C)+AC(1\text{-}B)+BC(1\text{-}A)+ABC$

substitute u for A, B, and C and reduce:

$uXu(1\text{-}u)+uXu(1\text{-}u)+uXu(1\text{-}u)+uXuXu=$

$u^2(1\text{-}u)+u^2(1\text{-}u)+u^2(1\text{-}u)+u^3=$

$3u^2(1\text{-}u)+u^3=$

$3u^2-3u^3+u^3=$

$3u^2-2u^3=$ conflict

Additional Waste

But when a, b, c want the machine, only one can use it and two must wait. Therefore, we must double the last time (i.e., ABC) in the formula to account for this additional waste. Our formula for waste is:

$3u^2 - u^3 =$ waste

If we added a machine to our pool, we would have conflict only when all three wanted the machine (i.e., ABC or u^3). This would be our waste formula for 3 people and 2 machines.

As we know the amount of time we must reduce waste to warrant an additional machine (i.e., 30 mins./day), our problem is to devise a formula that will give us the reduction in waste due to the addition of a machine to a machine pool. To do this we must subtract from our waste formula for 3 people and 1 machine the waste formula for 3 people and 2 machines.

$(3u^2 - u^3) - (u^3)$ or $3u^2 - 2u^3$ - reduction of waste due to the addition of a machine

Evolve Other Formulas

In like manner, we can evolve formulas to cover any combination of machines and operators. Listed below are the formulas for the more common combinations of machines and operators:

If you have		*Addition of one machine*
Operators	*Machines*	*will reduce waste*
2	1	u^2
3	1	$3u^2 - 2u^3$
4	1	$6u^2 - 8u^3 + 3u^4$
5	1	$10u^2 - 20u^3 + 15u^4 - 4u^5$
6	1	$15u^2 - 40u^3 + 45u^4 - 24u^5 + 5u^6$
3	2	u^3
4	2	$4u^3 - 3u^4$
5	2	$10u^3 - 15u^4 + 6u^5$
6	2	$20u^3 - 45u^4 + 3u^5 - 10u^6$
4	3	u^4
5	3	$5u^4 - 4u^5$
6	3	$15u^4 - 24u^5 + 10u^6$
5	4	u^5
6	4	$6u^5 - 5u^6$
6	5	u^6

To illustrate actual application of the formulas, let us return to the 3 operator, 1 machine case cited earlier.

We also shall use the adding machine example used above. We decided that we must save 30 minutes per day to make purchase of a manual machine desirable. Likewise in a sharing situation, we must reduce waste 30 minutes per day to warrant addition of a machine to a pool. We, therefore, equate our formula for reduction in waste to 30 minutes per day and solve. As our formula is stated in proportions of a day we must convert 30 mins./day to a proportion of a day. We use 400 minutes as the average work day. To convert 30 mins./day to a proportion we divide by 400.

$$3u^2 - 2u^3 = \frac{30}{400} = 0.075$$

$u = .1676$

We now change our answer back to minutes per day by multiplying by 400 mins./day.

0.1676×400 mins./day $= 67.04$ mins./day

This is the usage of one person; our pool has three so we must multiply the usage by three:

$3u = 3 \times 67.04$ mins./day $= 201.12$ mins./day

Our standard is: if 3 operators use one machine 201.12 minutes or more per day, purchase an additional machine for the pool.

Our complete set of standards is:

IF: # of machine(s) used is (are)														
	1	1	1	1	1	2	2	2	2	3	3	3	4	4	5
and # of operators using machine(s) is (are) and															
	2	3	4	5	6	3	4	5	6	4	5	6	5	6	6
total machine usage is (mins./day)															
	219	201	194	191	187	506	458	439	426	837	763	728	1191	1094	1558

Purchase additional electric machine, but if machine is to be used as a true spare, purchase a manual adding machine.

A big question now arises: Why do we recommend purchase of an electric adding machine when our sharing standards are based on our demanded time savings for a manual machine, namely 30 mins./day? It seems that we have been inconsistent.

Half the Usage

We know, as a practical matter, that we could place a new machine for a pool on one of the operators' desks. If we did this in the case of the 3 operator 1 machine pool used to illustrate our method, the new machine would receive about half the usage (i.e., ½ of 201 mins./day or 100 mins./day). A 100 minutes a day is well beyond the usage demanded for an electric machine. Therefore, we recommend purchase of an electric machine. However, we qualify this statement by saying if a machine is used as a true spare purchase a manual model.

By a true spare, we mean a machine used only when the existing machine is being used by another. This means the extra machine would be used only when two or more operators needed an adding machine simultaneously. Then, the extra machine would only be used 30 mins./day which would justify a manual model, not an electric. We know this situation of a true spare seldom arises, but we qualify our standards to cover this possibility.

Reduce Travel Time

We also feel that by placing a machine on an operator's desk, we reduce travel time enough to justify the additional cost of the electric.

At this point, a few words on machine pools would probably be apt. Pools must be set up on a practical basis. If there are a large number of operators and machines in one office, the operators and machines should be divided into several smaller pools instead of one large pool. The following rules are good guides in establishing pools:

1. Pools should have approximately equal work loads.
2. Each operator in a pool should have approximately equal work loads.
3. Travel distance should be kept at a minimum.

Administering Standards

There are several comments on administering standards that might be worth noting.

1. We must always recognize special situations that call for individual consideration. These instances are rare, but do appear from time to time. In these cases a machine must be justified on the individual conditions.
2. Our standards are expressed in minutes of usage. We mean average usage. Usually a month will give a representative figure of average usage. However, if particular conditions demand, a longer or shorter study may be required.
3. Usage time may be obtained by: actual timing, having the operator record the starting and ending time of each time he uses a machine, or by attaching an automatic recording device (e.g., stroke counter for typewriters, or electric current recorder for electric machines).
4. The problem of whether or not to replace a worn out machine in a pool operation is determined by considering what would happen if the machine is not replaced. In effect, we mentally reduce a pool by one machine and redistribute the work load. If the resulting situation warrants an additional machine according to our standards, we replace.

Conclusion

In conclusion, I point out that our method is not perfect or foolproof in that it contains some assumptions. I believe, however, that a sound set of standards are an infinitely better basis for purchase than a supervisor's statement that he thinks a machine is needed. And certainly, pre-figured standards are more economical than individual analyses of every purchase. **s/p/a**

Charles I. Keelan, as Office Methods Specialist at Johns-Manville Corporation, is responsible for office systems and procedures at his company. He is a member of the Office Management Planning Council of AMA and a consultant to the General Services Administration on the use standards for office machines.

Too Much Paperwork?

The Budget Bureau knows that many business executives think that entirely too much paperwork is required by the government. So the Bureau is inviting specific complaints, to be addressed to Bureau of the Budget, Executive Office Building, Washington 25, D. C.

The Bureau's purpose is twofold: In addition to keeping the business man reasonably sane, happy, and profit-making, it hopes to simplify and reduce the great number of official forms on which information is supplied to Washington.

Worth Reading

"How to Win Active Support for an Electronics Program"—Wesley S. Bagby, *Management Methods*, May 1956

Explains how the Pacific Mutual Life Insurance Company handled the introduction of a computer which resulted in the elimination of 150 positions.

"Forms—Their design, control, usage"—George Biek, *Office Management*, April 1956

Conclusion of a series which covered the field of forms control and reproduction based upon the experience of General Foods Corporation. The article deals with the mechanics of forms preparation, techniques for eliminating obsolete forms and ways of determining the most economical method of reproduction, including consideration of establishing a company print shop. Includes a table of costs for various methods of reproduction performed by a company and outside print shop.

"Management *Can* Understand Operations Research"—Van Court Hare, *Management Methods*, May 1956

The basic facts of linear programming are explained in a question and answer format in simple non-technical language.

"Fast and Flexible Inventory Control by Mechanization"—Frank E. Klecan, *NACA Bulletin*, April 1956

Detailed illustrated description of how Lockheed Aircraft Corporation uses bookkeeping machines and tabulating equipment for inventory control. The system yields average unit prices and extended listings mechanically each month.

"Qualifications for Supervision of an Electronics Office"—John W. Carr III, *The Office*, April 1956

Consideration of the responsibilities of the position and the types of abilities most needed. The author believes that an understanding of languages, a knowledge of logical methods of description and a feel for the use of automatic machines in the nearly automatic fashion are prime requisites.

"Linear Responsibility Charting—A Methods Tool"—Joseph D. Liptak, *NACA Bulletin*, May 1956

Explanation of a new methods tool similar to a work distribution chart. It is useful in comparing the same function in several units, evaluating work assignments and aids in work simplification.

"Ledger Postings—Are They Necessary Daily?"—Walter L. Stocker, *Modern Office Procedures*, March 1956

Describes a multi-copy voucher check system used in a 16-man office. The advantages claimed are several: many less postings, ability to prepare a Profit and Loss Statement seven days after the first of the month, and expenses can be readily analyzed. It eliminates a voucher register, accounts payable ledger, and month-end proving of accounts payable balances.

"The Tail That Wags the Dog"—William F. Buhl, *Modern Office Procedures*, May 1956

A three-record machine-posted system is used in a Goodrich Rubber plant to control production scheduling, product inspection, accumulated shipments, and fulfillment of customer delivery requirements. The three records are a ledger card for in-process material, a ledger card for finished goods, and a two-part proof tape used to control accuracy of posting production results.

"Electronic Data Processing and the Controller"—Richard G. Canning, *The Controller*, April 1956

Detailed consideration of the impact of EDPM on the role of controllers. Suggests that it is now possible to combine into one operation financial and physical control of a large enterprise and that with this control should go the authority to require corrective action.

"How a Steel Company Simplified Procedure in Receiving Material"—*Office Executive*, April 1956

Describes the adoption of a carbon interleaved pad to replace separate non-carbon pads used by several plants receiving material from different warehouses in the area.

"Deciding upon an Electronic Data Processing System"—Wesley S. Bagby, *The Controller*, May 1956

Detailed description of a two-year exploration of EDPM by an insurance company. Includes details of justification of the purchase, orientation of employees, and pre-installation work, and the process by which various systems were evaluated.

"Save $32,000 by Working Easier"—Lillian Stemp, *American Business*, April 1956

Describes A. B. Dick's work simplification program for the 500 office employees of the 1500-man company.

"There's Money in Forms Control"—Dwight G. Baird, *American Business*, March 1956

Describes Ford Motor Company's forms control program covering 16 operating divisions, 43 plants and many depots and offices. Three general classes of forms are used: company wide, division wide, and those used at particular locations. Presently, the company uses 16,000 forms of which about 10% are company wide.

"How a Freight Line Cut Capital Investment Cost"—*American Business*, March 1956

A freight company with a fleet of 1000 units adopted a visible inventory record for controlling 3800 parts involved in its preventive maintenance program. Benefits of the system are (1) a $50,000 monthly turnover of stock is accomplished with capital of only $75,000 and (2) reduced acquisition and storage costs.

Book Reviews

SUCCESSFUL EXECUTIVE ACTION

By Edward C. Schleh, 246 pp. (Prentice Hall Inc. Englewood Cliffs, N. J. ($10.00)

Reviewed by Nicholas F. Manicardi, Western Electric Co., Inc., New York.

Practicing supervisors at all levels, top executives and plodding students of business administration often become impatient with the study of management principles. How often have we wondered what is the real "Knack," the "Know-how" of the successful executive. Common sense statements, bland logic, enumerations of principles, and tedious statistics confront us with a mass of facts that are often difficult to evaluate into their proper relative importance.

Few executives take time from their tasks to analyze and report the elements that require the closest attention. Professional management consultants have done this but since this is their stock in trade the information is not freely available. Edward C. Schleh in "Successful Executive Action" removes the barriers and freely shares the important lessons he has gained in his experience in the management consulting field.

The author's concepts are compatible with the formal training we receive in our business institutions and with the best morals and ethics of society. The book is an account of his concepts and has numerous cases to illustrate them. Simple language and a minimum of coined titles and phrases make this a practical reference book for any business man's library.

Guidance of personnel is discussed in detail giving new emphasis and proof to the setting of goals for the individual subordinate as against just getting wheels of action moving. Due allowance for error is shown in the chapter on Rule of Errors—a vital caution in assigning responsibility to others. The chapters on Control and on Staff are of particular interest to systems people for they express a philosophy of the correct application of the systems function with respect to staff, staff assignments, timing and coordination, accountability, status, and the sharing of credit between line and staff.

Most of the chapters aim at the leadership guidance that will stimulate attainment of goals and overall results. In this light, two chapters on Committees point out their dangers as well as how to use them for effective results. A form consisting of a list of questions with space for the reader's answers is included at the end of each chapter. This tool for self appraisal serves to point out to the reader the areas in his leadership conduct that need attention.

Throughout the text principles are tied to illustrations so that there is no doubt about the lesson that is being expressed. Scattered in the text are references to other literature that will aid the reader to further research in these concepts. The vast experience of the author gives us many hints and examples that should help in the application of the concepts stressed. **s/p/a**

MANUAL OF INDUSTRIAL ENGINEERING PROCEDURES

By John A. Patton (1955, $10, 144 pp.); available from the publisher, Wm. C. Brown Company, Dubuque, Iowa.

Reviewed by Richard W. Pomeroy, Fairbanks Associates, Greenwich, Conn.

This book by the head of John A. Patton Management Engineers, Inc., is a well-founded attempt to dispel the "air of mystery and magic" which many client firms associate with the work of industrial engineering specialists whom they hire on a consulting basis. Because many firms do not understand how a consultant arrived at a particular set of recommendations, they are frequently reluctant to put them into practice. The result is that the effort and money expended on the study are wasted.

The book is comprised of eleven chapters covering the entire field of industrial engineering and peripheral areas. The first chapter serves as an introduction to the book and the other chapters deal with Wage Incentives, Job Evaluation, Cost Control, Production Planning and Control, Plant Layout, Sales and Distribution Analysis, Personnel Selection, Employee Training, Inventory Control and Material Handling. Each chapter consists of a frank introductory statement of the importance, shortcomings and problematic aspects of the subject area, a detailed list of procedures to be followed in making the analysis and installation, a check list of critical points to be watched, and an extensive bibliography.

It is immediately obvious that this book was not just written—it was developed over a long period of time and experience; this is the type of material which a consulting firm gives to its staff members to direct their efforts and to assure thoroughness and compliance to principle. Such a consultant's operating manual is seldom made available to personnel outside the firm. As such it should go a long way toward explaining in detail exactly what the outside specialist does, how he does it and how the information he derives from his study is developed into a program of recommendations. It will explain his relationships with the operating and management personnel with whom he works, indicate problematic areas, often indicate the sources of the specialist's information. **s/p/a**

In our May issue, Book Review section, parts of the text of our reviews on "An Introduction to Automatic Computers" and on "Office Automation" were inadvertently transposed. Our apologies for any confusion this may have caused.

Number Eight of a Series

"She Must Answer the Helm"

by Leslie Matthies

A SKIPPER EXPECTS, when he turns the wheel to the right, that his vessel will start turning to the right too.

His hand on the wheel is his control over the course of his ship. The importance of his control will never be denied.

A manager is also a skipper. He guides an organization, and he too must have a wheel in his hand. If he turns the wheel to right and his organization keeps straight ahead, or goes left—what has happened to his control?

He needs effective controls in his hands at all times. If he feels great "lost motion" between his wishes and what his people actually do, does he have control?

An organization without control is no organization at all. It is merely a collection of people.

The professional systems man can provide the manager with effective control—control without lost motion between the wheel and the rudder.

With a carefully designed reports system, a manager can make his organization do what he wants it to do.

Hard-hitting, factual reports are a part of any good system installation. A good report, provided by a good system, can bring you facts upon which you can act immediately.

A poor, non-integrated reports "system" can leave you wondering what to do. How can you take action when two reports contradict each other?

How can you take action when your reports take concentrated study or interpretation?

A good reports system has been aptly called "a management intelligence system."

To manage, a man needs facts. He has to know both the good and the bad. And he has to know it *now*, not 30 days later.

He needs facts in such form that he can read the report, understand it, and have an order out for correction in five minutes.

In a day or two, his report system can also tell him *if* the corrective action was taken!

An organization, like a ship, must answer the helm. If it doesn't, it will flounder while the skipper twists the wheel helplessly. **s/p/a**

How to Avoid Accounting Bottleneck

By W. H. Wright. Business, Vol. LXXXVI, No. 2, February 1956

A manufacturer has introduced cycle billing to eliminate its month-end accounting bottleneck, i.e. the rendering of statements to many thousands of customers, both retail and wholesale.

Cycle billing often involves the amalgamation of invoice and statement, but after investigation the company decided to continue to send out invoice and statement separately.

The office is divided into four groups: Group I handles all correspondence, claims, and credit notes; Group II prepares receipts for all cash and traders' credits; it also acts as a master control for groups III and IV and so makes it unnecessary to reset machines in these groups. Groups III and IV split the accounts between them.

Groups III and IV are manned by four operators each. The first girl in each team is the operator; the second 'feeds' her and also acts as relief operator. The third marks-up all cash and discount from cheques on to the account cards and passes the remittance slips back to Group II for receipting. The fourth member operates as a sort of audit clerk.

No complaints have been received about the change-over from either retailers or wholesalers. The company's sales representatives are pleased with the system; they can now expect to receive copy statements on a fixed date each month, which helps them with their own paper work.—(*British Institute of Management*).

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